Product Information

SAMSUNG TFT-LCD

MODEL NO．：LTM150XO-L21

Contents

General Description

* Description

LTM150XO-L01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 15.0" contains 1024 x 768 pixels and can display up to 16.2 millions colors.

* Features

   - High contrast ratio, high aperture structure
   - TN (Twisted Nematic) mode
   - Wide viewing angle
   - High speed response
   - XGA (1024 x 768 pixels) resolution
   - Low power consumption
   - 2 CCFTs (Cold Cathode Fluorescent Tube)
   - DE (Data Enable) mode
   - LVDS (Low Voltage Differential Signaling) interface (1pixel/clock)
   - Compact Size Design
   - Pb-free configuration
   - RoHS compliance

* Applications

   Desktop monitors
   Display terminals for AV application products
   Monitors for industrial machine

* General information

Items	Specification	Unit	Note
Display area	304.128(H) x 228.096(V)	mm	
Driver element	a-Si TFT active matrix		
Display colors	16.2M	colors	
Number of pixels	1024 x 768	pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.297(H) x 0.297(W)	mm	
Display mode	Normally White		
Surface treatment	Haze 25%, Hard-coating (3H)		

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* Mechanical information

Item		Min.	Typ.	Max.	Note
Module size	Horizontal(H)	326.0	326.5	327.0	mm
	Vertical(V)	253.0	253.5	254.0	mm
	Depth(D)	-	-	12.0	mm
Weight		-	-	1,050	g

1. Absolute Maximum Ratings

1.1 Absolute ratings of environment

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T_{STG}	-25	60	℃	(1)
Operating temperature (Glass surface temperature)	T_{OPR}	0	50	℃	(1)
Shock (non - operating)	Snop	-	50	G	(2),(4)
Vibration (non - operating)	Vnop	-	1.5	G	(3),(4)

Note (1) Temperature and relative humidity range are shown in the figure below.

90 % RH Max. (40 °C ≥ Ta)

Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C)   No condensation.

(2) 11ms, sine wave, one time for   ±X, ±Y, ±Z axis

(3) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

(4) At vibration and shock test, the fixture which holds the module to be tested has to be hard and rigid enough so that the module would not be twisted or bent by the fixture.
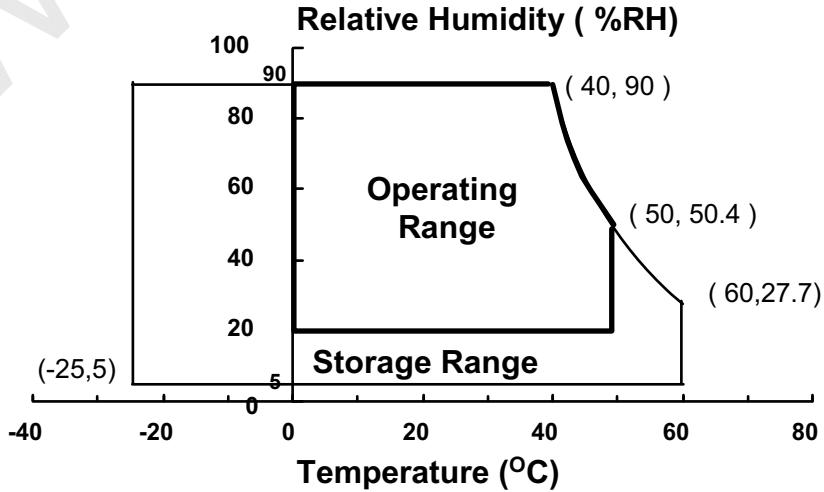
1.2 ELECTRICAL   ABSOLUTE   RATINGS

(1) TFT LCD Module   (Vss = GND = 0 V)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	Vss-0.3	4.0	V	(1)

Note (1)   Within Ta (25 ± 2 °C)

(2) BACK-LIGHT UNIT   (Ta = 25 ± 2°C)

Item	Symbol	Min.	Max.	Unit.	Note
Lamp Current	IL	3.0	9.0	mArms	(1),(2)
Lamp Frequency	fL	40	80	kHz	(1)

Note (1)   Permanent damage to the device may occur if maximum values are exceeded.
Functional operation should be restricted to the conditions described
under Normal Operating Conditions.

(2)   Specified values are for a single lamp.
(Refer to the Note (1) in the page 13 for further information).

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2. Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).

Measuring equipment : TOPCON BM-5A, BM-7, PHOTO RESEARCH PR650
Eldim EZ-Contrast

(Inverter Freq. : 50 kHz)   * Ta = 25 ± 2°C, V_{DD}=3.3V,   fv= 60Hz, f_{DCLK}=65MHz, I_L = 8.0mA$_{rms}$

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R		500	700	-		(3) BM-5A
Response Time	Rising	Tr		-	2	4	msec	(5) BM-7
	Falling	Tf		-	6	10		
Luminance of White (Center of screen)		YL	Normal $\phi = 0$ $\theta = 0$ Viewing Angle	200	250	-	cd/m2	(6) BM-5A
Color Chromaticity (CIE 1931)	Red	Rx		0.600	0.630	0.660		(7) PR650
		Ry		0.300	0.330	0.360		
	Green	Gx		0.270	0.300	0.330		
		Gy		0.550	0.580	0.610		
	Blue	Bx		0.120	0.150	0.180		
		By		0.060	0.090	0.120		
	White	Wx		0.283	0.313	0.343		
		Wy		0.299	0.329	0.359		
Viewing Angle	Hor.	θ L	CR≥10	65	75	-	Degrees	(8) BM-5A
		θ R		65	75	-		
	Ver.	φ H		50	60	-		
		φ L		65	75	-		
Brightness Uniformity (9 Points)		Buni		-	-	25	%	(4) BM-5A

Note (1) Test Equipment Setup

The measurement should be executed in a stable, windless and dark room between 30min and 40min after lighting the back-light at the given temperature for stabilization of the back-light. This should be measured in the center of screen.

Single lamp current : 8.0mA (Refer to the note(1) in the page 13 for more information.)
Environment condition : Ta = 25 ± 2 °C

Photodetector	Field
BM-5A	2°
BM-7	2°
PR650	1°

Photodetector

Field

TFT - LCD Module

BM-5A：40㎝
BM-7 ：50㎝
PR650：50㎝

LCD Panel

The center of the screen
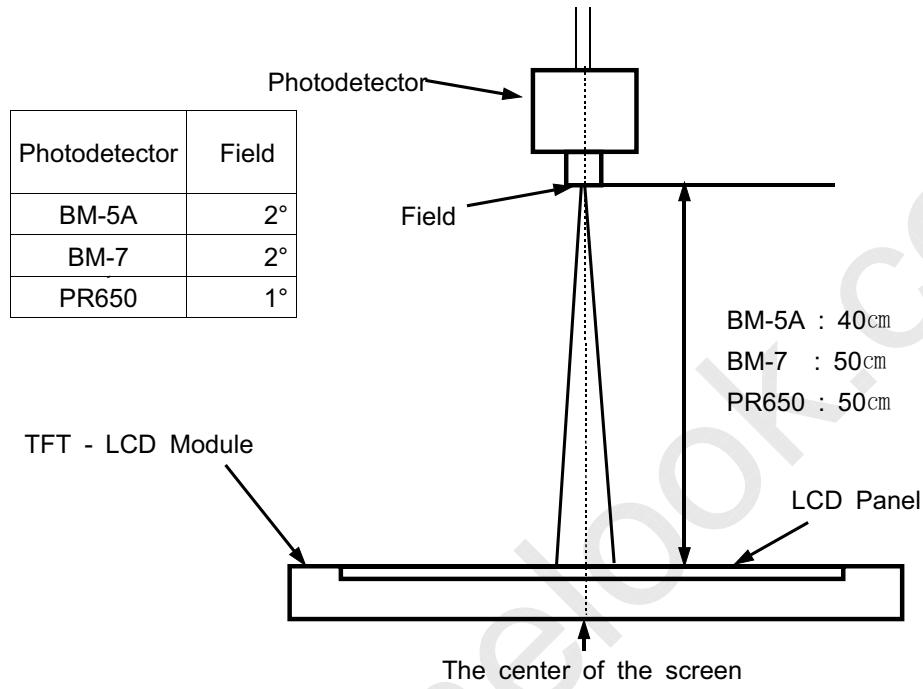
Optical Measuring Equipment Setup

Note (2) Definition of test point

128   512   896

VIEW AREA

9   8   7   96

6   5   4   384

3   2   1   670
(lines)

○ : test point
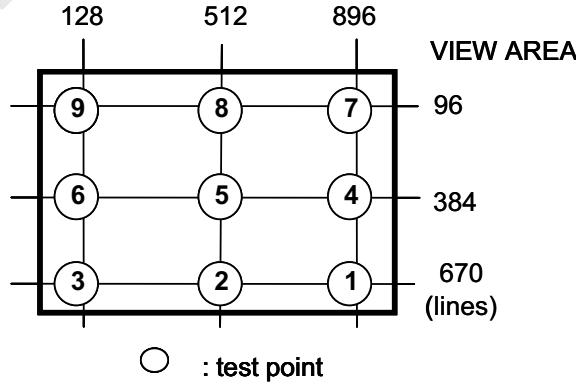
Note (3) Definition of Contrast Ratio (C/R)

: Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

$$CR = \frac{G \max}{G \min}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note (4) Definition of 9 points brightness uniformity

$$Buni = 100 * \frac{(B \max - B \min)}{B \max}$$

Bmax : Maximum brightness

Bmin : Minimum brightness

Note (5) Definition of Response time : Sum of Tr, Tf

Display data

| WHITE(data off) | BLACK(data on) | WHITE(data off) |

Optical Instruments Response

T_R　　　T_F

100%
90%
10%
0%

TIME
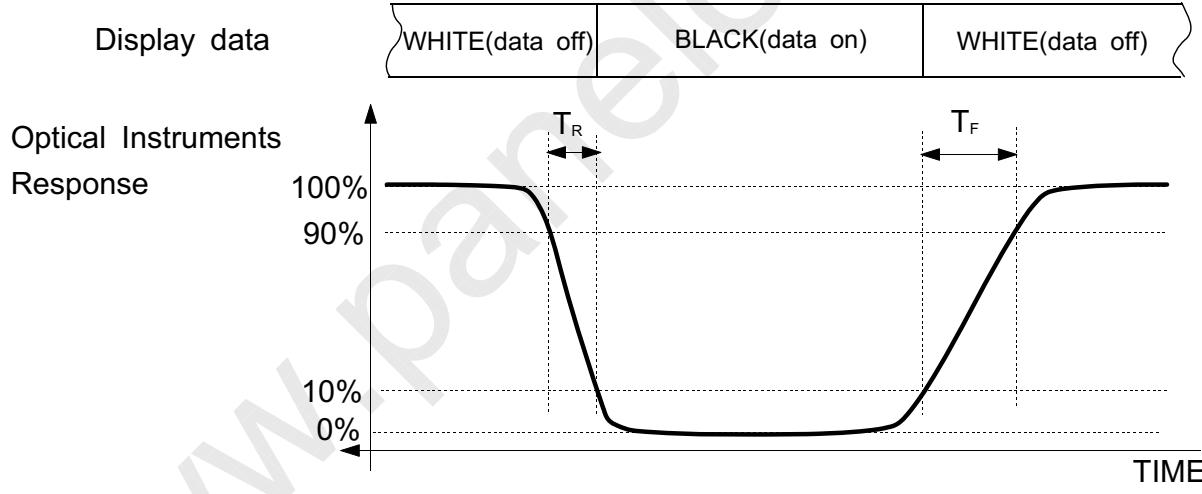
Note (6) Definition of Luminance of White : Luminance of white at center point⑤.

Note (7) Definition of Color Chromaticity (CIE 1931)

Color coordinate of Red, Green, Blue & White at center point⑤.

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Note (8) Definition of Viewing Angle : Viewing angle range (CR ≥10)
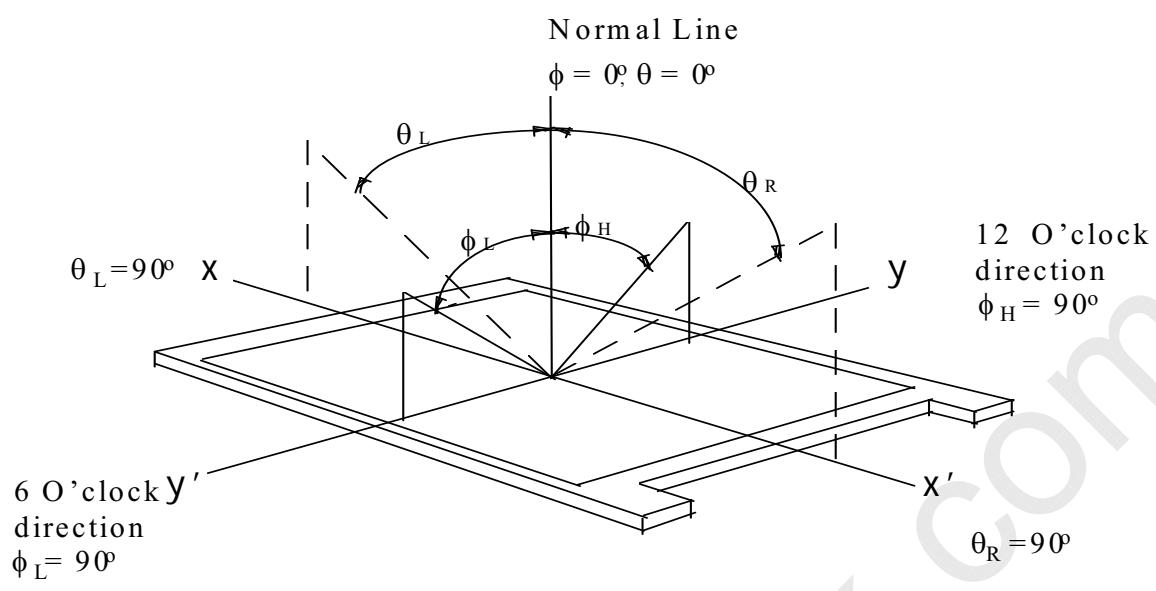
3. Electrical Characteristics

3.1 TFT LCD MODULE

Ta = 25°C

| ITEM		SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Power Supply Voltage		V_{CC}	3.0	3.3	3.6	V	(1)
Differential Input Threshold Voltage		V_H	-	-	+100	mV	V_{CM} =1.2V
		V_L	-100	-	-	mV	
Power Consumption	(a) White		-	600	-	mA	(2),(3)
	(b) Black		-	650	-	mA	
	(c) Dot		-	700	800	mA	
Vsync Frequency		fV	55	60	77	Hz	-
Hsync Frequency		fH	47.6	48.4	62	KHz	
Main Frequency		fDCLK	50	65	80	MHz	
Rush Current		I_{RUSH}	-	-	3.0	A	(5)

Note (1) The connector for display data & timing signal should be connected.(Vss=0V)

(2) fV = 60Hz, fDCLK = 65MHz, VDD = 3.3V, DC Current.

(3) Power dissipation check pattern(LCD Module only)

a) Black Pattern　　　　b) White Pattern

c) Dot Pattern
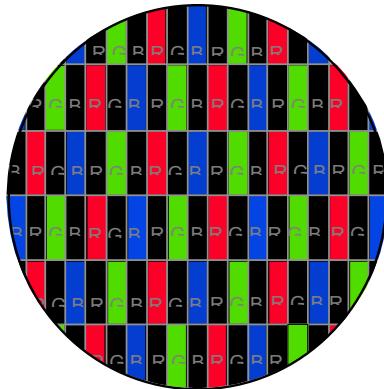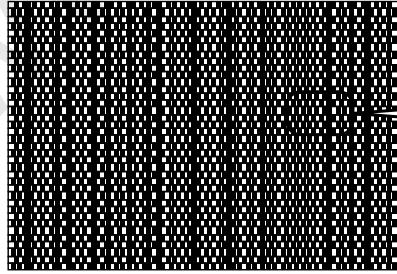
(4) Measurement Conditions
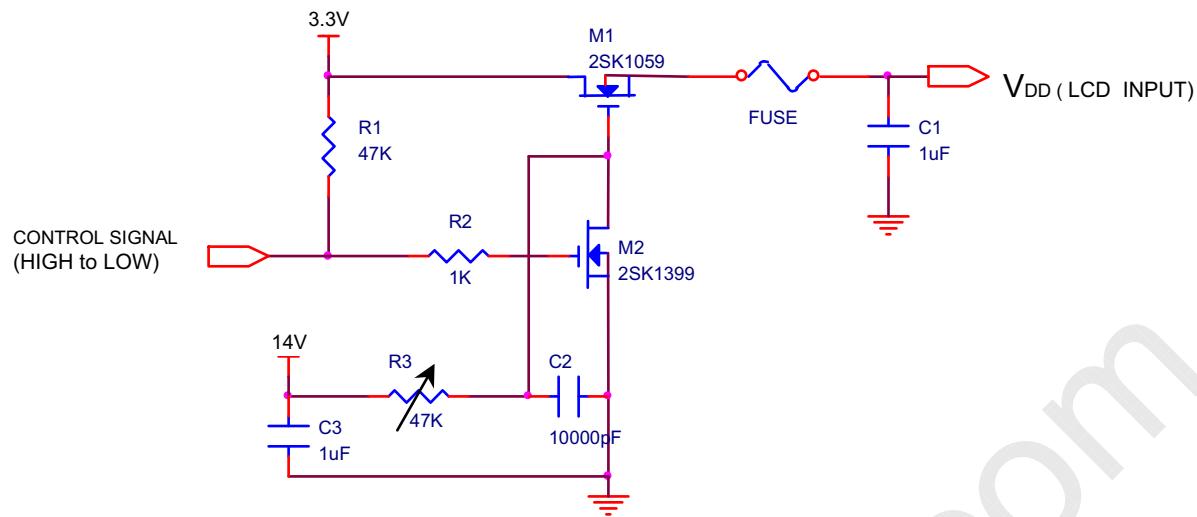
Control Signal : High(+3.3V) →Low(Ground)

All Signal lines to panel, except for power 3.3V : Ground

The rising time of supplied voltage is controlled to 470us by R3 and C2 value.

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3.2   BACK-LIGHT UNIT

The back-light system is an edge - lighting type with 2 CCFTs (Cold Cathode
Fluorescent Tube) The characteristics of two lamps are shown in the following tables.

Ta=25 ± 2°C

| Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	I$_L$	3.0	8.0	9.0	mArms	(1)
Lamp Voltage	V$_L$	-	560	-	Vrms	
Lamp Frequency	f$_L$	40	-	60	kHz	(2)
Operating Life Time	Hr	50,000	-	-	Hour	(3)
Startup Voltage	Vs	-	-	25℃:1,450 0℃ :1,680	Vrms	(4)

**Note)   The wave form of the inverter output voltage must be area symmetric and the design
of the inverter must have specifications for the modularized lamp.**

The performance of the back-light, for example life time or brightness, is much influenced by the
characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be
carefully designed so as not to produce too much leakage current from high-voltage output of the
inverter. When you design or order the inverter, please make sure that a poor lighting caused by the
mismatch of the back-light and the inverter(poor lighting, flicker, etc.) never occur. When you confirm
it, the module should be operated in the same condition as it is installed in your instrument.

Note (1) Lamp current is measured with current meter for high frequency as shown below.
Refer to the block diagram of the back-light unit in the next page for more information.
Specified values are for a single lamp.
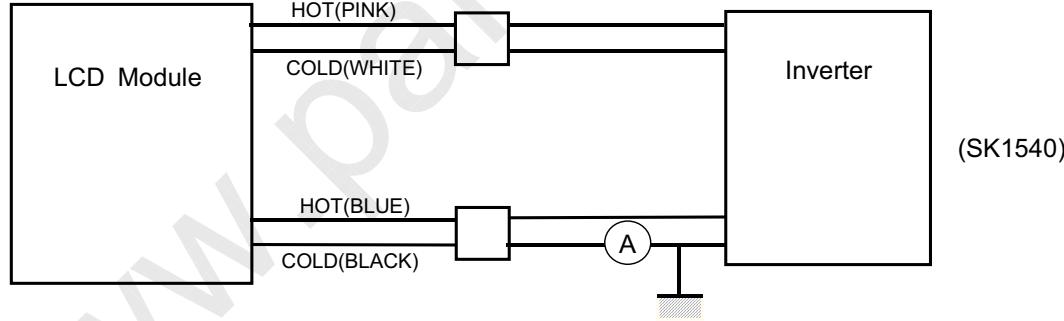
(2) Lamp frequency which may produce interference with horizontal synchronous frequency may
cause line flow on the display. Therefore lamp frequency should be detached from the horizontal
synchronous frequency and its harmonics   as far as possible in order to avoid interference.

(3) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the
condition of Ta = 25±2°C and I$_L$ = 8.0mArms for a lamp until the brightness becomes 50%
or lower than it's original value. Operating condition is lamp unit itself, not module assembly at
operating current 8.0mA.

(4) If an inverter has shutdown function, it should keep its output for over 1 second even if the
lamp connector is open. Otherwise the lamps may not be turned on.

(5) Because the inverter uses high voltage, please disconnect it from the power before
assembling or disassembling.

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4. Block Diagram

4.1 TFT LCD MODULE
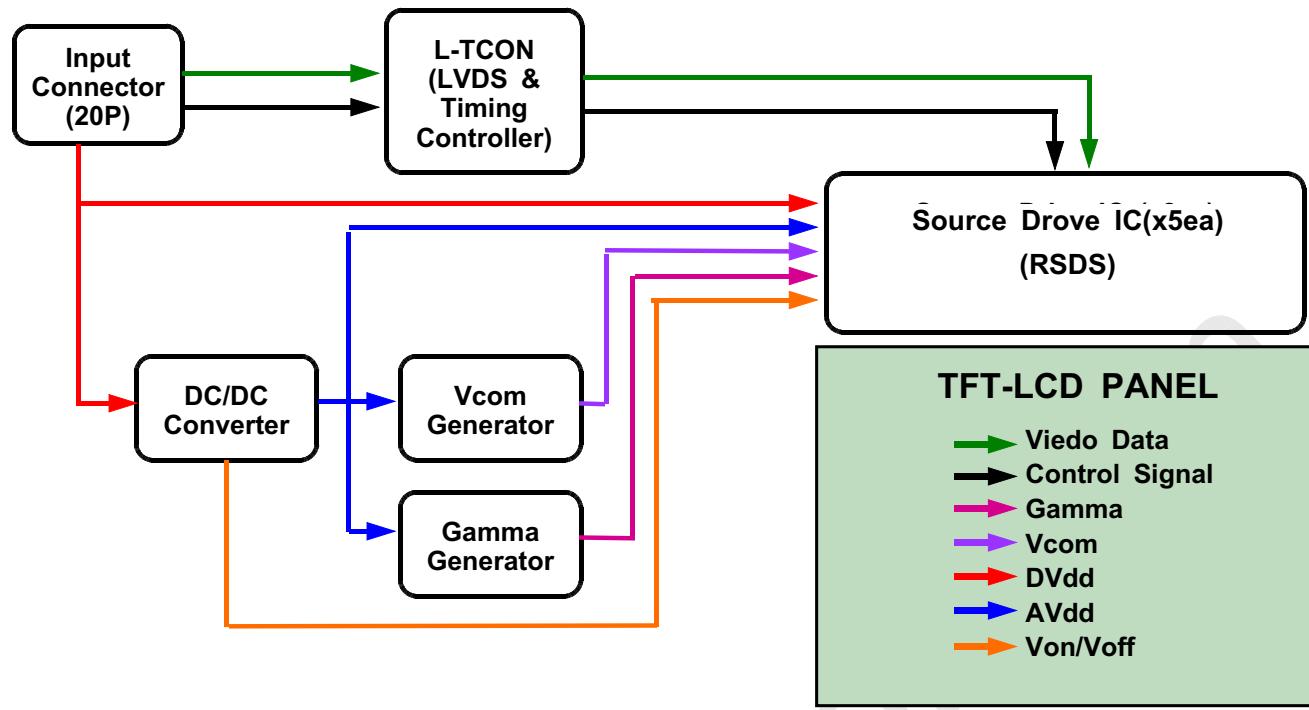
4.2 BACK-LIGHT UNIT

Connector : JST BHR-03VS-1(Module-side)
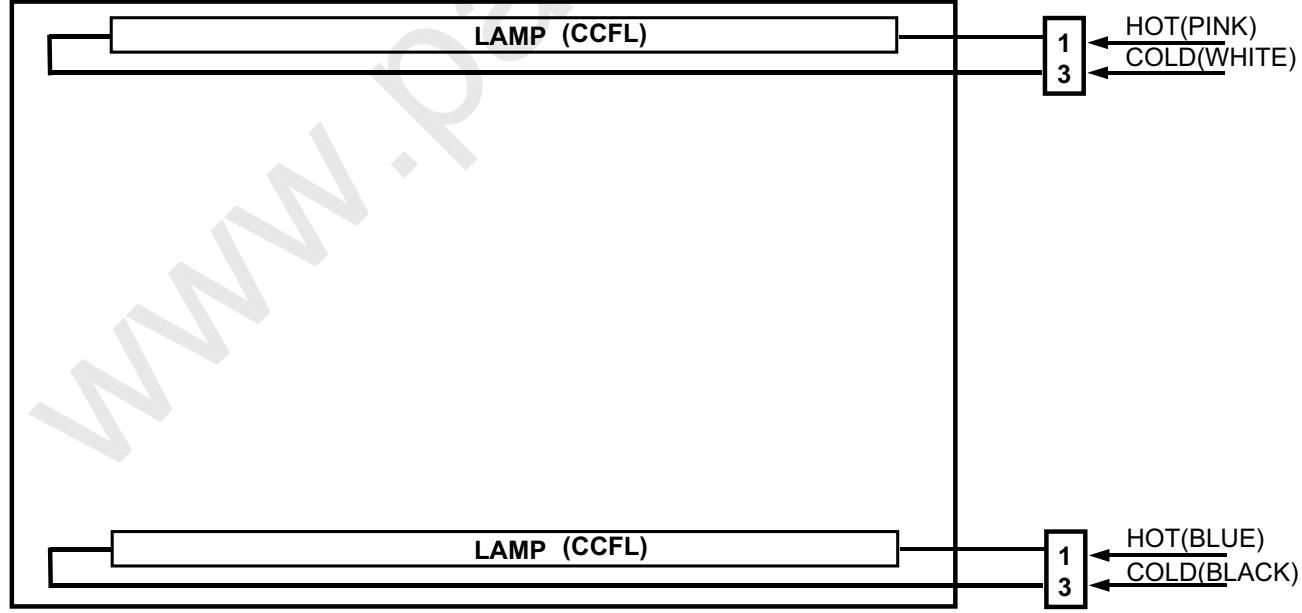
5. Input Terminal Pin Assignment

5.1. Input Signal & Power   (Connector : Hirose DF14H-20P-1.25H or Equivalent)

Pin No.	Symbol	Function	Remark
1	VDD	Power Supply 3.3V	
2	VDD	Power Supply 3.3V	
3	GND	Ground	
4	GND	Ground	
5	OD-RX0-	ODD Receiver Signal(-)	
6	OD-RX0+	ODD Receiver Signal(+)	
7	GND	Ground	
8	OD-RX1-	ODD Receiver Signal(-)	
9	OD-RX1+	ODD Receiver Signal(+)	
10	GND	Ground	
11	OD-RX2-	ODD Receiver Signal(-)	
12	OD-RX2+	ODD Receiver Signal(+)	
13	GND	Ground	
14	OD-RXCLK-	ODD Receiver Clock Signal(-)	
15	OD-RXCLK+	ODD Receiver Clock Signal(+)	
16	GND	Ground	
17	OD-RX3-	ODD Receiver Signal(-)	
18	OD-RX3+	ODD Receiver Signal(+)	
19	*CE	For LCD internal use only. Do not Connect.	
20	*CTL	For LCD internal use only. Do not Connect.	

Note) * If the system already uses the 19 , 20pins, it should keep under GND level.
        The Voltage applied to those pins should not exceed -200mV.

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5.2   LVDS Interface

DS90C385
THC63LVDM83A

DF14H-20P-1.25H

Host System 24-bit

Host signal	Pin	Tx signal	Tx pin	Conn pin	Ω	Conn pin	Rx pin	Rx signal
RED0	51							
RED1	52	TxOUT0-	48	5		9		RxIN0-
RED2	54				100Ω	10		
RED3	55	TxOUT0+	47	6				RxIN0+
RED4	56							
RED5	3	TxOUT1-	46	8		11		RxIN1-
RED6	50				100Ω	12		
RED7	2	TxOUT1+	45	9				RxIN1+
GREEN0	4							
GREEN1	6							
GREEN2	7	TxOUT2-	42	11		15		RxIN2-
GREEN3	11				100Ω	16		
GREEN4	12	TxOUT2+	41	12				RxIN2+
GREEN5	14							
GREEN6	8							
GREEN7	10	TxCLKOUT-	40	14		17		RxCLKIN-
BLUE0	15				100Ω	18		
BLUE1	19	TxCLKOUT+	39	15				RxCLKIN+
BLUE2	20							
BLUE3	22							
BLUE4	23	TxOUT3-	38	17		19		RxIN3-
BLUE5	24				100Ω	20		
BLUE6	16	TxOUT3+	37	18				RxIN3+
BLUE7	18							
Hsync	27							
Vsync	28							
Enable	30							
CLOCK	31							

Note : The LCD Module uses a 100ohm resistor between positive and negative lines of each
        receiver input.

5.3   Back-Light Unit

Pin No.	Input [ch1]	Color	Function
1	Hot1	Pink(U), Blue(D)	High Voltage
2	NC	-	No connection
3	Cold1	White(U), Black(D)	Ground
Connector Part No.	JST BHR-03VS-1 (Module side socket) or equivalent		

5.4 Pixel Format

DATA1   DATA2   DATA1024

Line 1   R G B R G B   R G B R G B

LTM150XO-L01 Panel

Line768   R G B R G B   R G B R G B

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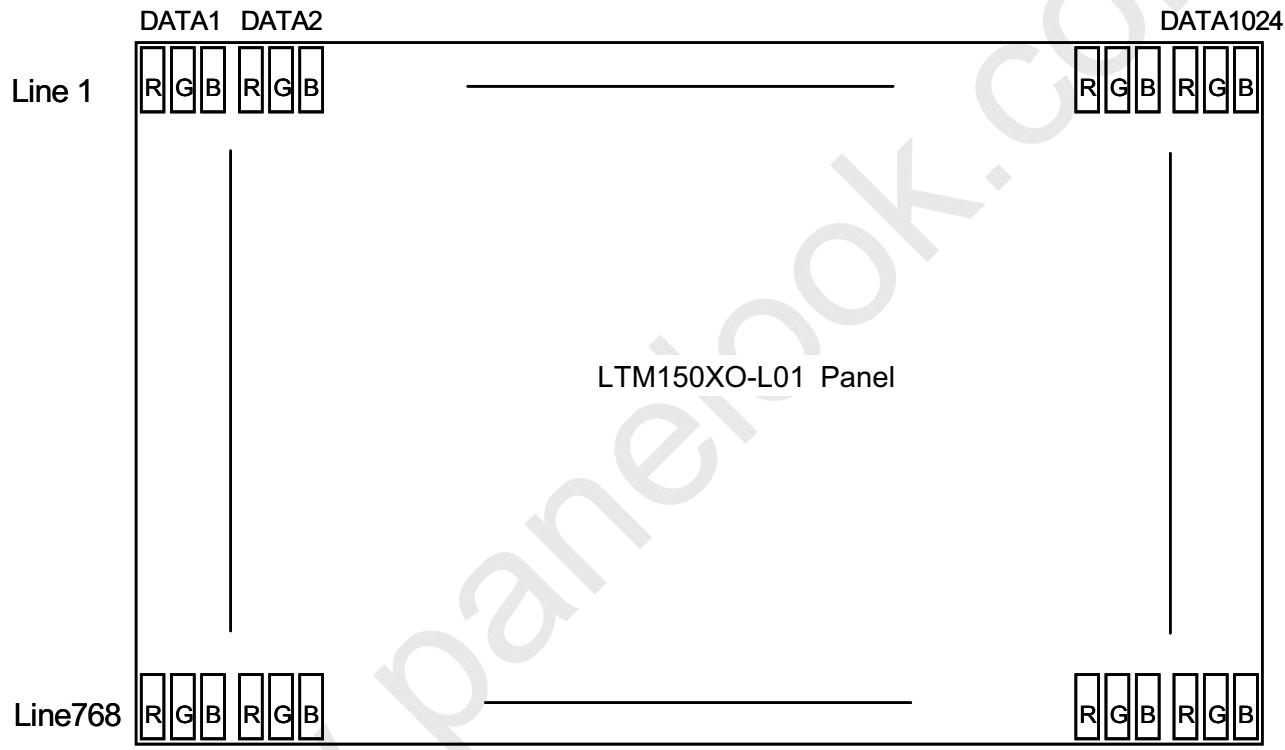
5.5 Input Signals, Basic Display Colors and Gray Scale of Each Colors

COLOR	DISPLAY (8bit)	R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7	GRAY SCALE LEVEL
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	-
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	-
	CYAN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	MAGENTA	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	-
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	-
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
GRAY SCALE OF RED	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R0
	DARK ↑	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1
		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
	:	:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			R3~
	:	:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			R252
	↓	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R252
	LIGHT	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R252
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R252
GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0
	DARK ↑	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G1
		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G2
	:	:	:	:	:	:	:			:	:	:	:	:				:	:	:	:	:	:			G3~
	:	:	:	:	:	:	:			:	:	:	:	:				:	:	:	:	:	:			G252
	↓	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G252
	LIGHT	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G252
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G252
GRAY SCALE OF BLUE	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B0
	DARK ↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	B1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	B2
	:	:	:	:	:	:	:			:	:	:	:	:				:	:	:	:	:	:			B3~
	:	:	:	:	:	:	:			:	:	:	:	:				:	:	:	:	:	:			B252
	↓	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	B252
	LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	B252
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	B252

Note) Definition of Gray

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

6. Interface Timing

6.1   Timing Parameters   (DE only mode)

SIGNAL	ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT
Clock	Frequency	1/TC	50	65	80	MHz
	High Time	TCH	2	-	-	nsec
	Low Time	TCL	2	-	-	nsec
Data	Setup Time	TDS	4	-	-	nsec
	Hold Time	TDH	4	-	-	nsec
Data Enable	Setup Time	TES	2	-	-	nsec
Frame Frequency	Cycle	Tv	-	16.7	12.9	msec
			772	806	870	lines
Vertical Active Display Term	Display Period	TVD	768	768	768	lines
One Line Scanning Time	Cycle	TH	1244	1344	1494	clocks
Horizontal Active Display Term	Display Period	THD	1024	1024	1024	clocks

Note (1) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

(2) Internal Vcc = 3.3V

6.2   Timing diagrams of interface signal (DE only mode)
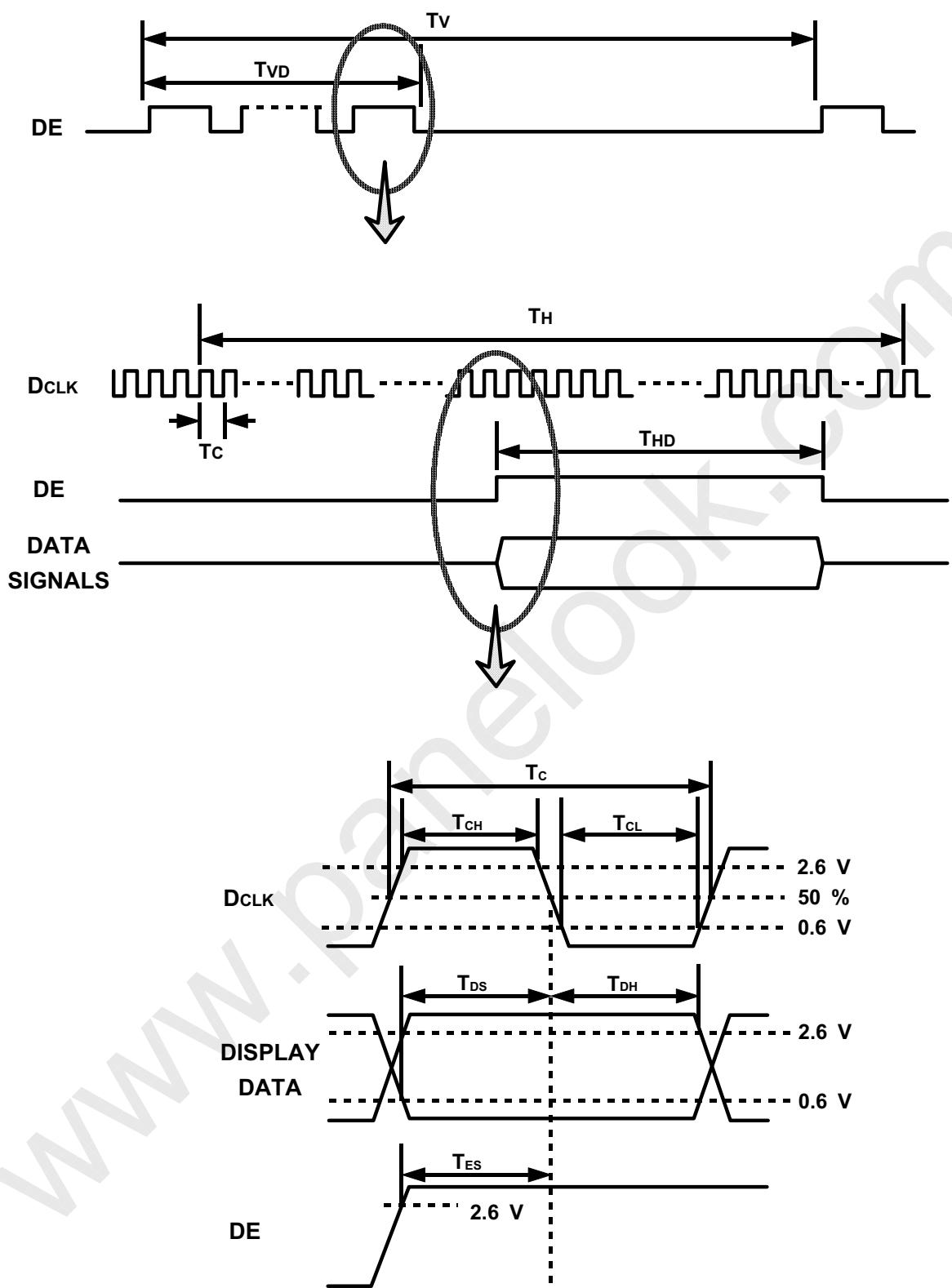
6.3   Power ON/OFF Sequence

To prevent a latch-up or DC operation of the LCD module, the power on/off sequence
should be as the diagram below.

Power Supply
VDD

$300\mu s \le T_1 \le 10msec$
$0 \le T_2 \le 50\ msec$
$0 \le T_3 \le 50\ msec$
$1sec \le T_4$

Signals

0.9 VDD
0.1 VDD
0V

0.9 VDD
0.1 VDD

T_1
T_2

T_3
T_4

VALID

0 V

Power On

Power Off

Back-light(Recommended)
$500\ msec \le T_5$
$100\ msec \le T_6$

50%   50%

T_5 T_6

Power ON/OFF Sequence
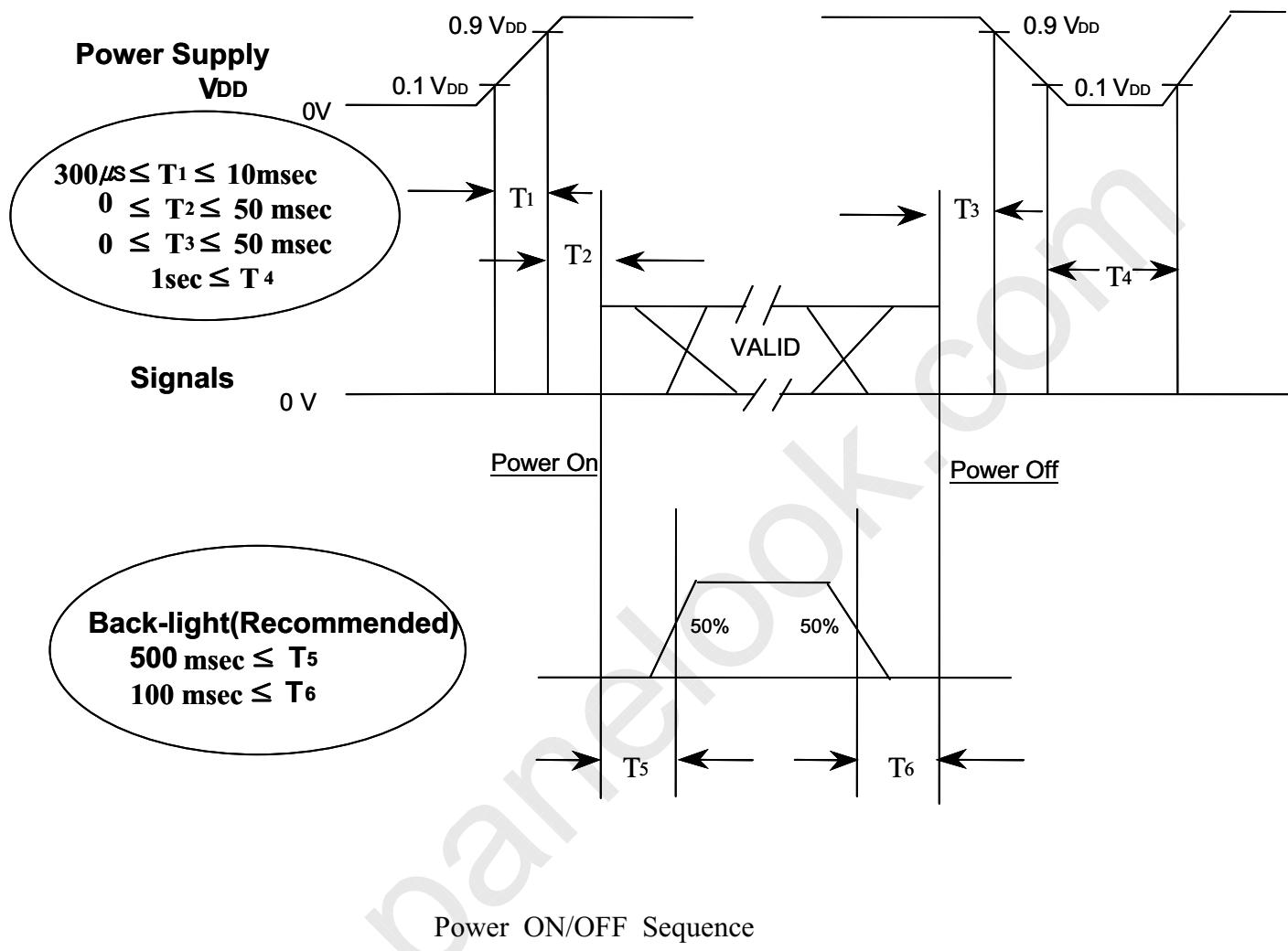
Note. (1) The supply voltage of the external system for the module input should be the
same as the definition of VDD.

(2) Apply the lamp voltage within the LCD operation range. When the back-light
turns on before the LCD operation or the LCD turns off before the back-light
turns off, the display may momentarily show abnormal screen.

(3) In case of VDD = off level,
please keep the level of input signals low or keep a high impedance.

(4) T4 should be measured after the module has been fully discharged between
power off and on period.

(5) Interface signal should not be kept at high impedance when the power is on.

7. Outline Dimension

[Refer to the next page]

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* NOTES
1. Confirm & Requirement

1) INPUT CONN. SPEC.
   - PART NO : HIROSE (DF14H-20P-1.25H)
     or OAXX(1H-2D-DW 12.5)

2) DET7 LAMP CONN. SPEC.
   - PART NO : JST,1208H-03(4.0)Y-S(3 PIN x 150mm)

3) ALLOWED DEPTH OF USER HOLE SCREW INSERTION IS 3.0mm MAX

4) USER MOUNTING TORQUE SPEC : 7 Kgf·cm

SAMSUNG ELECTRONICS
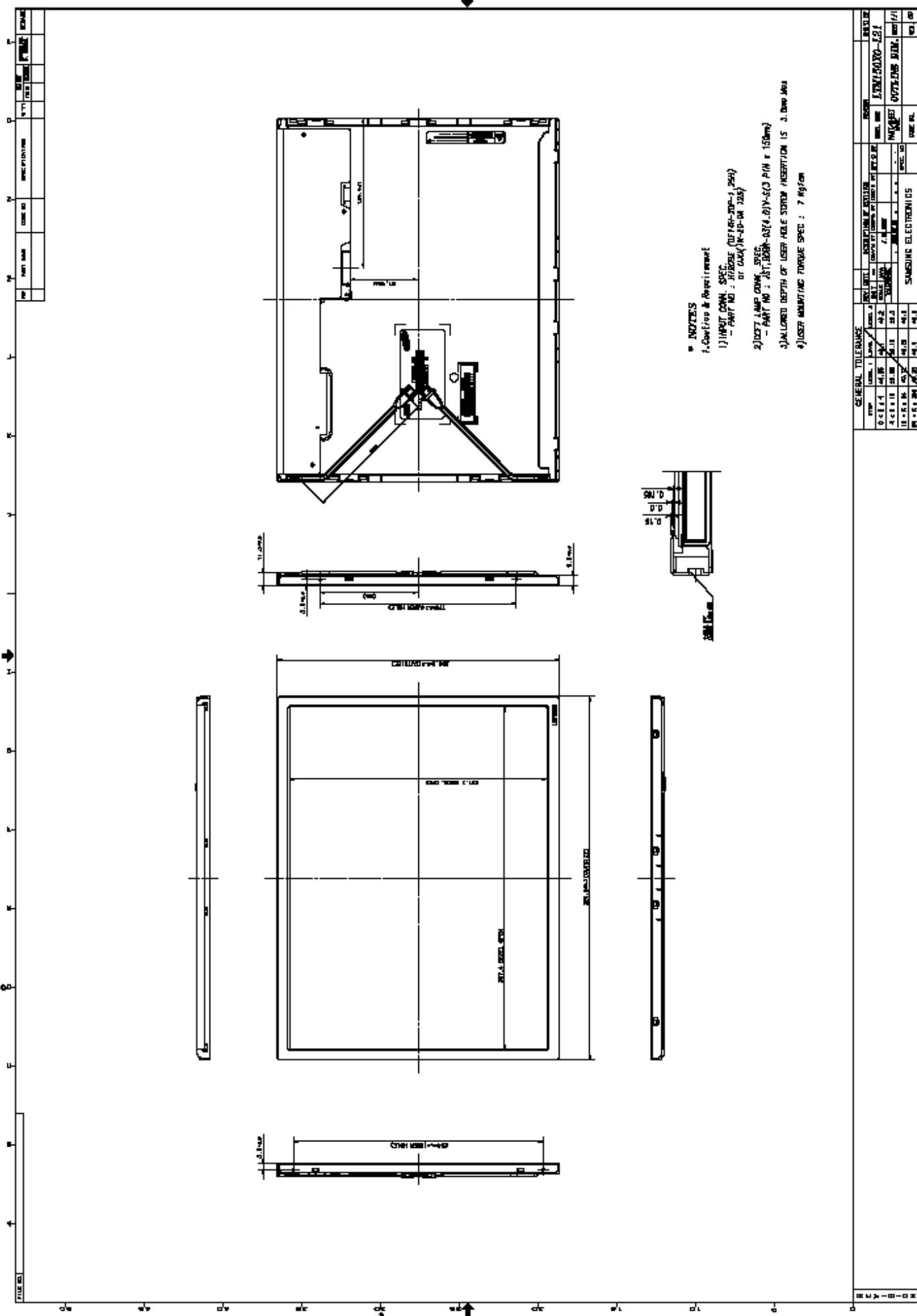
8.   General Precautions

8.1 Handling

(a) When the module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the module.

(b) Because the inverter use high voltage, it should be disconnected from power before it is assembled or disassembled.

(c) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and CCFT back-light.

(d) Note that polarizers are very fragile and could be damage deasily.
Do not press or scratch the surface harder than a HB pencil lead.

(e) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.

(f) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(g) Desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane.
Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.

(h) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away with soap thoroughly.

(i) Protect the module from static, or the CMOS Gate Array IC would be damaged.

(j) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(k) Do not disassemble the module.

(l) Do not pull or fold the lamp wire.

(m) Do not adjust the variable resistor located on the module.

(n) Protection film for polarizer on the module should be slowly peeled off just before use so that the electrostatic charge can be minimized.

(o) Pins of I/F connector should not be touched directly with bare hands.

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8.2 Storage

  (a) Do not leave the module in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35℃ and relative humidity of less than 70%.

  (b) Do not store the TFT-LCD module in direct sunlight.

  (c) The module should be stored in a dark place. It is prohibited to apply sunlight or fluorescent light in storing.

8.3 Operation

  (a) Do not connect or disconnect the module in the "Power On" condition.

  (b) Power supply should always be turned on/off by the item 6.3 "Power on/off sequence"

  (c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference should be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

  (d) The cable between the back-light connector and its inverter power supply should be connected directly with a minimized length. A longer cable between the back-light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

8.4 Others

  (a) Ultra-violet ray filter is necessary for outdoor operation.

  (b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.

  (c) Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)
Otherwise the module may be damaged.

  (d) If the module keeps displaying the same pattern for a long period of time, the image may be "sticked" to the screen.

  (e) This module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.

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